CLAIMS

1. A control device of a legged mobile robot adapted to sequentially determine instantaneous values of a desired motion and a desired floor reaction force of a legged mobile robot that travels by moving legs extended from its body by using a dynamic model that expresses a relationship between at least a motion of the robot and a floor reaction force, and also to control an operation of the robot at the same time so as to make the robot follow the determined instantaneous values of the desired motion and the desired floor reaction force, comprising:

permissible range setting means for setting a permissible range of a restriction object amount, the restriction object amount being a vertical component of a floor reaction force moment or a component of the floor reaction force moment in floor surface normal line direction to be applied to a robot in operation, following the desired motion and the desired floor reaction force; and

desired instantaneous value determining means for determining, on the basis of at least a difference between a desired state amount related to a posture of the robot about a vertical axis or about a floor surface normal line axis and an actual state amount of the robot and the permissible range, instantaneous values of the desired motion and the desired floor reaction force such that a deviation between a floor reaction force moment balancing

with the desired motion on the dynamic model and a floor
reaction force moment of the desired floor reaction force
approximates the difference to zero, while having the
restriction object amount, which is associated with the

5   desired floor reaction force, fall within the permissible
range.

2. The control device of a legged mobile robot
according to Claim 1, wherein the desired instantaneous
value determining means comprises means for determining a

10 compensating floor reaction force moment, which is an
additional floor reaction force moment for approximating
the difference to zero on the basis of the difference, and
means for determining a correction amount of a
predetermined provisional instantaneous value such that

15 the restriction object amount does not exceed the
permissible range on the basis of at least a floor
reaction force moment that balances with the predetermined
provisional instantaneous value of the desired motion on
the dynamic model and the compensating floor reaction

20 force moment, wherein the provisional instantaneous value
is corrected on the basis of the determined correction
amount so as to determine an instantaneous value of the
desired motion.

3. The control device of a legged mobile robot

25 according to Claim 2, further comprising means for
determining a model correction floor reaction force moment,
which is an additional floor reaction force moment for

approximating a state amount of the dynamic model to a predetermined state amount, wherein the means for determining a correction amount of a predetermined provisional instantaneous value of the desired motion

5   determines a correction amount of a provisional instantaneous value of the desired motion such that the restriction object amount does not exceed the permissible range on the basis of at least a floor reaction force moment that balances with the predetermined provisional

10   instantaneous value on the dynamic model, the compensating floor reaction force moment, and the model correction floor reaction force moment.

4.   The control device of a legged mobile robot according to Claim 2 or 3, wherein the correction amount

15   of the predetermined provisional instantaneous value is a correction amount of a motion that changes a vertical component or a component in floor surface normal line direction of an angular momentum changing rate of the robot.

20   5.   The control device of a legged mobile robot according to Claim 4, wherein the motion that changes the vertical component or the component in floor surface normal line direction of the angular momentum changing rate of the robot is a motion of a body of the robot

25   and/or an arm extended from the body of the robot.

6.   A control device of a legged mobile robot adapted to sequentially determine an instantaneous value of a desired

motion of a legged mobile robot that travels by moving
legs extended from its body by using a dynamic model that
expresses a relationship between at least a motion of the
robot and a floor reaction force, and also to control an
5   operation of the robot at the same time so as to make the
robot follow the determined instantaneous value of the
desired motion, comprising:

permissible range setting means for setting a
permissible range of a restriction object amount, the
10   restriction object amount being a vertical component of a
floor reaction force moment or a component of the floor
reaction force moment in floor surface normal line
direction to be applied to a robot in operation, following
the desired motion;

15   compensating floor reaction force moment determining
means for determining a compensating floor reaction force
moment, which is an additional floor reaction force moment
for bringing a difference between a desired state amount
related to a posture of the robot about a vertical axis or
20   a floor surface normal line axis and an actual state
amount of the robot close to zero on the basis of at least
the difference; and

desired instantaneous value determining means for
determining an instantaneous value of the desired motion
25   such that the restriction object amount, which is
determined on the basis of a floor reaction force moment
balancing with the desired motion on the dynamic model and

the compensating floor reaction force moment, falls within the permissible range.

7. The control device of a legged mobile robot according to Claim 6, further comprising means that defines the restriction object amount falling within the permissible range as a desired floor reaction force moment, and controls the operation of the robot so as to make the robot follow the desired floor reaction force moment.

8. The control device of a legged mobile robot according to Claim 6 or 7, wherein the desired instantaneous value determining means determines an instantaneous value of the desired motion by adjusting a motion that changes a vertical component or a component in floor surface normal line direction of an angular momentum changing rate of the robot among motions of the robot in order to hold the restriction object amount, which depends on a floor reaction force moment balancing with the desired motion on the dynamic model and the compensating floor reaction force moment, within the permissible range.

9. The control device of a legged mobile robot according to Claim 8, wherein the motion that changes a vertical component or a component in floor surface normal line direction of an angular momentum changing rate of the robot is a motion of a body of the robot and/or an arm extended from the body.

10. A control device of a legged mobile robot adapted to sequentially determine an instantaneous value of a

desired motion of a legged mobile robot that travels by moving legs extended from its body by using a dynamic model expressing at least a relationship between a motion of the robot and a floor reaction force, and also to

5   control an operation of the robot at the same time so as to make the robot follow the determined instantaneous value of the desired motion, comprising:

permissible range setting means for setting a permissible range of a restriction object amount, the

10   restriction object amount being a vertical component of a floor reaction force moment or a component of the floor reaction force moment in floor surface normal line direction to be applied to a robot in operation, following the desired motion;

15   provisional instantaneous value determining means for sequentially determining a provisional instantaneous value of the desired motion;

compensating floor reaction force moment determining means for determining a compensating floor reaction force

20   moment, which is an additional floor reaction force moment for bringing a difference between a desired state amount related to a posture of the robot about a vertical axis or a floor surface normal line axis and an actual state amount of the robot close to zero on the basis of at least

25   the difference; and

desired instantaneous value determining means for determining an instantaneous value of the desired motion

by defining a portion of the restriction object amount, which deviates from the permissible range, as a moment correction manipulated variable, the restriction object amount being determined on the basis of a floor reaction

5   force moment balancing with a provisional instantaneous value of the desired motion on the dynamic model and the compensating floor reaction force moment, and by correcting the provisional instantaneous value of the desired motion on the basis of the moment correction

10   manipulated variable such that the deviating portion indicates a tendency to decrease.

11.   The control device of a legged mobile robot according to Claim 10, wherein the desired instantaneous value determining means determines an instantaneous value

15   of the desired motion by determining a correction amount of a provisional instantaneous value of the desired motion on the basis of a result obtained by passing the moment correction manipulated variable through a low-pass filter, and then by correcting the provisional instantaneous value

20   on the basis of the determined correction amount.

12.   The control device of a legged mobile robot according to Claim 10, further comprising means for defining, as a desired floor reaction force moment, a floor reaction force moment corresponding to an already

25   restricted restriction object amount that has been limited by restricting the restriction object amount, which is determined on the basis of a floor reaction force moment

balancing with a provisional instantaneous value of the desired motion on the dynamic model and the compensating floor reaction force moment, to fall within the permissible range, and for controlling an operation of a

5   robot so as to make the robot follow the desired floor reaction force moment.

13.   The control device of a legged mobile robot according to any one of Claims 10 to 12, wherein the desired instantaneous value determining means determines

10   an instantaneous value of the desired motion by correcting a motion for changing a vertical component or a component in floor surface normal line direction of an angular momentum changing rate of the robot on the basis of a provisional instantaneous value of the desired motion.

15   14.   The control device of a legged mobile robot according to Claim 13, wherein the motion for changing a vertical component or a component in floor surface normal line direction of an angular momentum changing rate of the robot is a motion of a body of the robot and/or an arm

20   extended from the body.

15.   The control device of a legged mobile robot according to any one of Claims 1, 6 and 10, wherein the state amount related to a posture of the robot includes a yaw angle or a yaw angular velocity of the body of the

25   robot.

16.   The control device of a legged mobile robot according to any one of Claims 1, 6 and 10, further

comprising slippage determining means for determining

occurrence of a slippage of the robot, wherein the

permissible range setting means variably sets the

permissible range according to a determination result of

5   the slippage determining means.

17.   The control device of a legged mobile robot

according to Claim 16, wherein the slippage determining

means determines the occurrence of a slippage on the basis

of at least the ground speed of a distal portion of a leg

10   in contact with the ground.

18.   The control device of a legged mobile robot

according to Claim 16, wherein the slippage determining

means comprises means for determining, on the basis of at

least a temporal changing rate of an actual floor reaction

15   force acting on a leg in contact with the ground and the

ground speed of a distal portion of the leg, an apparent

spring constant of the leg, and determines the occurrence

of a slippage on the basis of at least the apparent spring

constant.

20   19.   The control device of a legged mobile robot

according to Claim 16, wherein the slippage determining

means determines the occurrence of a slippage on the basis

of at least a result obtained by passing an actual floor

reaction force acting on a leg in contact with the ground

25   through a band-pass filter having a frequency passing

characteristic in a range near a predetermined frequency.

20.   A control device that generates a desired gait of a

legged mobile robot that travels by moving a plurality of legs extended from its body, and controls an operation of the robot so as to make the robot follow the desired gait, comprising:

5   means for determining a compensating floor reaction force moment, which is an additional floor reaction force moment for bringing a difference between a desired state amount related to a posture of the robot about a vertical axis or a floor surface normal line axis and an actual

10   state of the robot close to zero on the basis of at least the difference;

       permissible range setting means for setting a permissible range of a restriction object amount, the restriction object amount being a vertical component of a

15   floor reaction force moment or a component of the floor reaction force moment in floor surface normal line direction to be applied to a robot in operation, following the desired gait;

       provisional instantaneous value determining means for

20   determining a provisional instantaneous value of a desired motion constituting the desired gait;

       model calculating means that inputs at least a provisional instantaneous value of the desired motion to a dynamic model representing a relationship between a motion

25   of the robot and a vertical component or a component in floor surface normal line direction of a floor reaction force moment balancing with the motion so as to determine

a vertical component or a component in floor surface
normal line direction of a floor reaction force moment as
an output of the dynamic model, and then determines an
instantaneous value of a model restriction object amount,

5   which is a provisional instantaneous value of the
restriction object amount by carrying out predetermined
calculation from the determined vertical component or the
component in floor surface normal line direction and the
compensating floor reaction force moment; and

10   desired instantaneous value determining means for
determining an instantaneous value of the desired motion
by correcting a provisional instantaneous value of the
desired motion such that at least the instantaneous value
of the model restriction object amount falls within the

15   permissible range.

    21.   The control device of a legged mobile robot
according to Claim 20, wherein the desired instantaneous
value determining means determines a floor reaction force
moment instantaneous value corresponding to an

20   instantaneous value of a restriction object amount, which
is determined by the predetermined calculation from a
vertical component or a component in floor surface normal
line direction of a floor reaction force moment
substantially balancing with an instantaneous value of the

25   desired motion on the dynamic model and the compensating
floor reaction force moment, as an instantaneous value of
a floor reaction force moment of a desired floor reaction

force constituting the desired gait.

22. The control device of a legged mobile robot according to Claim 20, wherein the desired instantaneous value determining means comprises:

5   a perturbation model representing a relationship between a perturbative motion of the robot and a perturbative portion of a vertical component or a component in floor surface normal line direction of a floor reaction force moment;

10   means for determining a perturbation model manipulated variable for manipulating a perturbative portion of the perturbation model on the basis of at least the determined instantaneous value of the model restriction object amount and the permissible range;

15   means for determining a correction amount of the desired motion by supplying the determined perturbation model manipulated variable to the perturbation model; and

means for determining an instantaneous value of the desired motion by correcting a provisional instantaneous

20   value of the desired motion by using the correction amount.

23. The control device of a legged mobile robot according to Claim 22, wherein the means for determining the perturbation model manipulated variable comprises means for determining, on the basis of at least the

25   determined instantaneous value of the model restriction object amount, an estimated value of the restriction object amount in a case where the perturbation model

manipulated variable is assumed to be zero, and means for
comparing the determined estimated value with the
permissible range to determine, on the basis of the
comparison, a restricted restriction object amount that

5   has been restricted to fall within the permissible range,
and determines the perturbation model manipulated variable
on the basis of at least a difference between the
determined instantaneous value of the model restriction
object amount and the restricted restriction object amount.

10   24.   The control device of a legged mobile robot
according to Claim 22, further comprising:
        means for determining a required value of the
perturbation model manipulated variable on the basis of at
least a state amount of the perturbation model,

15   wherein the means for determining the perturbation
model manipulated variable determines a perturbation model
manipulated variable to be supplied to the perturbation
model on the basis of at least the determined
instantaneous value of the model restriction object amount,

20   the permissible range, and the required value.
        25.   The control device of a legged mobile robot
according to Claim 24, wherein the means for determining a
required value of the perturbation model manipulated
variable sequentially determines the required value

25   according to a feedback control law on the basis of a
difference between a state amount of the perturbation
model and a desired value relative to the state amount.

26. The control device of a legged mobile robot according to Claim 24, wherein the means for determining the perturbation model manipulated variable comprises means for determining an estimated value of the

5 restriction object amount in a case, where the perturbation model manipulated variable is assumed to agree with the required value, on the basis of at least the determined instantaneous value of the model restriction object amount and the required value, and

10 means for comparing the determined estimated value with the permissible range to determine, on the basis. of the comparison, a restricted restriction object amount that has been limited to the permissible range, and determines the perturbation model manipulated variable on the basis

15 of at least a difference between the determined instantaneous value of the model restriction object amount and the restricted restriction object amount.

27. The control device of a legged mobile robot according to Claim 22, wherein the desired instantaneous

20 value determining means comprises means for additionally inputting a correction amount of the desired motion to the dynamic model.

28. The control device of a legged mobile robot according to Claim 22, wherein the perturbation model is a

25 model that represents a relationship between a perturbative motion perturbing a vertical component or a component in floor surface normal line direction of an

angular momentum changing rate of a robot and a
perturbation portion of the restriction object amount.

29. The control device of a legged mobile robot
according to Claim 28, wherein the perturbative motion is
a perturbative motion that maintains the position of a
center-of-gravity of the robot substantially constant.

30. The control device of a legged mobile robot
according to Claim 28 or 29, wherein the perturbative
motion is a perturbative motion of a body of the robot
and/or an arm extended from the body.

31. A control device for generating a desired gait of a
legged mobile robot that travels by moving a plurality of
legs extended from its body and for controlling an
operation of the robot so as to make the robot follow the
desired gait, comprising:

means for determining a compensating floor reaction
force moment, which is an additional floor reaction force
moment for bringing a difference between a desired state
amount related to a posture of the robot about a vertical
axis or a floor surface normal line axis and an actual
state of the robot close to zero on the basis of at least
the difference;

permissible range setting means for setting a
permissible range of a restriction object amount, the
restriction object amount being a vertical component of a
floor reaction force moment or a component in floor
surface normal line direction of the floor reaction force

moment to be applied to a robot in operation, following the desired gait;

a desired floor reaction force provisional instantaneous value determining means for sequentially

5 determining a provisional instantaneous value of at least a desired floor reaction force out of a desired motion and the desired floor reaction force constituting the desired gait;

first model calculating means for inputting at least

10 a provisional instantaneous value of the desired floor reaction force to a first dynamic model expressing a relationship between a motion of the robot and a floor reaction force so as to sequentially determine a provisional instantaneous value of a desired motion as an

15 output of the first dynamic model;

second model calculating means for inputting at least the provisional instantaneous value of the desired motion to a second dynamic model expressing a relationship between a motion of the robot and a vertical component or

20 a component in floor surface normal line direction of a floor reaction force moment balancing with the motion thereby to determine the vertical component or the component in floor surface normal line direction of the floor reaction force moment as an output of the second

25 dynamic model, and for determining an instantaneous value of a model restriction object amount, which is a provisional instantaneous value of the restriction object

amount, by carrying out predetermined calculation from the determined vertical component or component in floor surface normal line direction and the compensating floor reaction force moment; and

5   first model input correcting means for determining a floor reaction force moment correction amount of a desired floor reaction force so as to hold at least the instantaneous value of the model restriction object amount within the permissible range, and for additionally

10   inputting the determined floor reaction force moment correction amount to the first dynamic model,

wherein the instantaneous value of the desired motion is determined on the basis of at least the input of the second dynamic model.

15   32.   The control device of a legged mobile robot according to Claim 31, further comprising means for determining a floor reaction force moment instantaneous value corresponding to an instantaneous value of a restriction object amount, which is determined from a

20   vertical component or a component in floor surface normal line direction of a floor reaction force moment substantially balancing with an instantaneous value of the desired motion on the second dynamic model and the compensating floor reaction force moment by the

25   predetermined calculation, as an instantaneous value of a floor reaction force moment of a desired floor reaction force constituting the desired gait.

33.   The control device of a legged mobile robot
according to Claim 31, wherein the first model input
correcting means comprises means for determining, on the
basis of at least the determined instantaneous value of
5   the model restriction object amount, an estimated value of
the restriction object amount in a case where at least a
floor reaction force moment correction amount of the
desired floor reaction force is assumed to be zero, and
means for comparing the determined estimated value with
10   the permissible range to determine, on the basis of the
comparison, a restricted restriction object amount that
has been limited to the permissible range, and determines
the floor reaction force moment correction amount on the
basis of at least a difference between the determined
15   instantaneous value of the model restriction object amount
and the restricted restriction object amount.

34.   The control device of a legged mobile robot
according to Claim 31, further comprising:
means for determining a required value of a floor
20   reaction force moment correction amount of the desired
floor reaction force,
wherein the first model input correcting means
comprises means for determining, on the basis of at least
the determined instantaneous value of the model
25   restriction object amount and the required value, an
estimated value of the restriction object amount when at
least the floor reaction force moment correction amount of

the desired floor reaction force is assumed to agree with the required value, and means for comparing the determined estimated value with the permissible range, and then determining a restricted restriction object amount limited to the permissible range on the basis of the comparison, and determines the floor reaction force moment correction amount on the basis of at least a difference between the determined instantaneous value of the model restriction object amount and the restricted restriction object amount.

35.   The control device of a legged mobile robot according to Claim 31, further comprising second model input correcting means for determining a correction amount of the desired motion on the basis of at least the determined instantaneous value of the model restriction object amount and the permissible range, and then additionally inputting the determined correction amount to the second dynamic model.

36.   The control device of a legged mobile robot according to Claim 35, further comprising:

a perturbation model that represents a relationship between a perturbative motion of the robot and a perturbation portion of a restriction object amount;

means for determining a manipulated variable of a floor reaction force moment on the basis of at least the determined instantaneous value of the model restriction object amount and the permissible range; and

distributing means for dividing the determined

manipulated variable of the floor reaction force moment
into a floor reaction force moment correction amount of
the desired floor reaction force to be supplied to the
first dynamic model and a perturbation model manipulated

5   variable to be supplied to the perturbation model,

wherein the second model input correcting means
determines a correction amount of the desired motion by
supplying the perturbation model manipulated variable to
the perturbation model.

10   37.   The control device of a legged mobile robot
according to Claim .36, further comprising:

means for determining a required value of a
manipulated variable of the floor reaction force moment on
the basis of at least a state amount of the perturbation

15   model,

wherein the means for determining a manipulated
variable of the floor reaction force moment determines a
manipulated variable of the floor reaction force moment to
be supplied to the distributing means on the basis of at

20   least the determined instantaneous value of the model
restriction object amount, the permissible range, and the
required value.

38.   The control device of a legged mobile robot
according to Claim 37, wherein the means for determining a

25   required value of a manipulated variable of the floor
reaction force moment sequentially determines the required
value according to a feedback control law on the basis of

a difference between a state amount of the perturbation
model and a desired value relative to the state amount.

39. The control device of a legged mobile robot
according to Claim 36, wherein the perturbation model is a
model that represents a relationship between a
perturbative motion perturbing a component of an angular
momentum changing rate of a robot about a vertical axis or
about a floor surface normal line axis and a perturbation
portion of the restriction object amount.

40. The control device of a legged mobile robot
according to Claim 39, wherein the perturbative motion is
a perturbative motion that maintains the position of a
center-of-gravity of the robot substantially constant.

41. The control device of a legged mobile robot
according to Claim 39 or 40, wherein the perturbative
motion is a perturbative motion of a body of the robot
and/or an arm extended from the body.

42. The control device of a legged mobile robot
according to Claim 36, wherein the means for determining a
manipulated variable of the floor reaction force moment
comprises means for determining, on the basis of at least
the determined instantaneous value of the model
restriction object amount, an estimated value of the
restriction object amount in a case where the perturbation
model manipulated variable is assumed to be zero, and
means for comparing the determined estimated value with
the permissible range to determine, on the basis of the

comparison, a restricted restriction object amount limited
to the permissible range, and determines the manipulated
variable of the floor reaction force moment on the basis
of at least a difference between the determined

5   instantaneous value of the model restriction object amount
and the restricted restriction object amount.

43.   The control device of a legged mobile robot
according to Claim 37, wherein the means for determining
the manipulated variable of the floor reaction force

10   moment comprises means for determining an estimated value
of the restriction object amount in a case, where the
perturbation model manipulated variable is assumed to
agree with the required value, on the basis of at least
the determined instantaneous value of the model

15   restriction object amount and the required value, and
means for comparing the determined estimated value with
the permissible range to determine, on the basis of the
comparison, a restricted restriction object amount limited
to the permissible range, and determines the manipulated

20   variable of the floor reaction force moment on the basis
of at least a difference between the determined
instantaneous value of the model restriction object amount
and the restricted restriction object amount.

44.   A control device for generating a desired gait of a

25   legged mobile robot that travels by moving a plurality of
legs extended from its body and for controlling an
operation of the robot so as to make the robot follow the

desired gait, comprising:

means for determining a compensating floor reaction force moment, which is an additional floor reaction force moment for bringing a difference between a desired state amount related to a posture of the robot about a vertical axis or a floor surface normal line axis and an actual state amount of the robot close to zero on the basis of at least the difference;

permissible range setting means for setting a permissible range of a restriction object amount, the restriction object amount being a vertical component of a floor reaction force moment or a component in floor surface normal line direction of the floor reaction force moment to be applied to a robot in operation, following the desired gait;

desired floor reaction force provisional instantaneous value determining means for sequentially determining a provisional instantaneous value of at least a desired floor reaction force out of a desired motion and a desired floor reaction force constituting the desired gait;

first model calculating means for inputting at least the provisional instantaneous value of a desired floor reaction force to a first dynamic model representing a relationship between a motion of the robot and a floor reaction force so as to determine a first provisional instantaneous value of a desired motion as an output of

the first dynamic model;

restricted second model calculating means, which is a means for determining a second provisional instantaneous value of a desired motion, and which determines the second

5   provisional instantaneous value of the desired motion on the basis of at least a provisional instantaneous value of the desired floor reaction force such that an instantaneous value of a restriction object amount that is determined by predetermined calculation from a vertical

10   component or a component in floor surface normal line direction of a floor reaction force moment, which balances with the determined second provisional instantaneous value on a second dynamic model representing a relationship between a motion of a robot and a floor reaction force,

15   and the compensating floor reaction force moment falls within the permissible range;

manipulated variable calculating means for determining a manipulated variable of a floor reaction force moment on the basis of at least a difference between

20   a first provisional instantaneous value and a second provisional instantaneous value of the desired motion such that the difference approaches zero; and

model input correcting means for additionally inputting the manipulated variable of the floor reaction

25   force moment to at least one of the first dynamic model and the second dynamic model,

wherein the second provisional instantaneous value of

the desired motion is determined as a desired
instantaneous value of the desired motion.

45.   The control device of a legged mobile robot
according to Claim 44, wherein the difference between the
first provisional instantaneous value and the second
provisional instantaneous value of the desired motion
includes a difference in a state amount of a posture of a
predetermined part of the robot about a vertical axis or a
floor surface normal line axis.

46.   The control device of a legged mobile robot
according to Claim 44, further comprising means for
determining a floor reaction force moment instantaneous
value corresponding to an instantaneous value of a
restriction object amount, which is determined from a
vertical component or a component in floor surface normal
line direction of a floor reaction force moment
substantially balancing with an instantaneous value of the
desired motion on the second dynamic model and the
compensating floor reaction force moment by the
predetermined calculation, as an instantaneous value of a
floor reaction force moment of a desired floor reaction
force constituting the desired gait.

47.   The control device of a legged mobile robot
according to Claim 34, further comprising a third model
calculating means for inputting at least a provisional
instantaneous value of the desired floor reaction force to
a third dynamic model representing a relationship between

a motion of the robot and a floor reaction force so as to determine a third provisional instantaneous value of a desired motion as an output of the third dynamic model, wherein the means for determining a required value of a

5   floor reaction force moment correction amount of the desired floor reaction force determines the required value on the basis of a difference between the determined desired instantaneous value of the desired motion and the third provisional instantaneous value of the desired

10   motion such that the difference approximates to zero.

48.   The control device of a legged mobile robot according to any one of Claims 20, 31 and 44, further comprising slippage determining means for determining the occurrence of a slippage of the robot in operation,

15   following the desired gait, wherein the permissible range setting means variably sets the permissible range according to a determination result of the slippage determining means.

49.   The control device of a legged mobile robot

20   according to Claim 48, wherein the slippage determining means determines the occurrence of a slippage on the basis of at least the ground speed of a distal portion of a leg in contact with the ground.

50.   The control device of a legged mobile robot

25   according to Claim 48, wherein the slippage determining means comprises means for determining, on the basis of at least a temporal changing rate of an actual floor reaction

force acting on the leg in contact with the ground and the ground speed of a distal portion of the leg, an apparent spring constant of the leg, and determines the occurrence of a slippage on the basis of at least the apparent spring

5   constant.

51.   The control device of a legged mobile robot according to Claim 48, wherein the slippage determining means determines the occurrence of a slippage on the basis of at least a result obtained by passing an actual floor

10   reaction force acting on the leg in contact with the ground through a band-pass filter having a frequency passing characteristic in a range near a predetermined frequency.